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FAR-END CALIBRATING AND TRANSFER DEVICE AND METHOD

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FAR-END CALIBRATING AND TRANSFER DEVICE AND METHOD

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The present invention pertains to a type of far-end calibrating and transfer device and method. In particular, the present invention pertains to a type of far-end calibrating and transfer device for an instrument and a far-end calibrating and transfer method that can be used to calibrate a measurement instrument. /5*

It is necessary to calibrate a measurement instrument to maintain its accuracy. To calibrate a measurement instrument, a special calibrator is usually used to provide an accurate electric calibration characteristic. Then, the instrument to be calibrated is used to measure this electric calibration characteristic to obtain the measurement error of this instrument so that the instrument can be adjusted appropriately. For example, when calibrating an electric meter, a calibrator is usually used to provide a prescribed voltage to perform calibration. Some calibrators, such as the Fluke 5700A multifunctional calibrator, can provide plural types of electric characteristics, such as voltage, resistance, capacitance, etc.

A calibrator is usually fairly expensive to an organization that needs to calibrate an instrument. Therefore, it is usually necessary to rent a calibrator from another organization (such as a national research institute) or to send a batch of measurement instruments to a place for calibration, which requires a large amount of manpower and material resources. In addition, the

* [The numbers in the right margin indicate pagination of the original foreign text.]

fact that the calibrated measurement instruments may be affected by some factors during the transportation must be taken into consideration. It is necessary to improve the conventional instrument calibrating method.

We now have an advanced communication system. If we can take advantage of the communication system to calibrate instruments, we can solve the aforementioned problems of the conventional instrument calibrating method.

In order to realize this purpose, the present invention provides the following:

Summary of the invention

The first characteristic of the present invention is a type of calibrating device, which can use a calibration signal in a first zone to calibrate a measurement instrument in a second zone. /6
This calibrating device includes a signal-generating unit that can generate the aforementioned calibration signal, a first converting unit that can convert the calibration signal based on a reference signal in a first range to generate a corresponding first digital signal, a feedback control unit that corrects the first digital signal based on at least one correcting value to generate a second digital signal, a second converting unit that converts the second digital signal based on a reference signal in a second range to generate a corresponding simulated calibration signal, a third converting unit that converts the simulated calibration signal based on a reference signal in a third range to generate a corresponding third digital signal. The feedback control unit continuously adjusts the second digital signal until the difference between the first and third digital signals is smaller than a prescribed value. The simulated calibration signal obtained at that time is a stable simulated calibration signal close to the calibration signal. The stable simulated calibration signal is used to calibrate the measurement instrument.

The signal-generating unit, the first converting unit, and the feedback control unit are arranged in the first zone. The second and third converting units are arranged in the second zone.

This calibrating device also includes a communication device, which transfers the first, second, and third digital signals between the first and second zones. The communication device is an Internet network system.

The correcting value includes the ratio between the first, second, and third ranges or the difference between the first, second, and third reference signal ranges.

The feedback control unit is installed in a computer.

The second characteristic of the present invention is a type of transfer device used to transfer an analog signal from the first zone to the second zone. This transfer device includes a first converting unit that converts the analog signal based on a reference signal in a first range to /7
generate a corresponding first digital signal, a feedback control unit that corrects the first digital signal based on at least one correcting value to generate a second digital signal sent to the second

zone; a second converting unit that converts the second digital signal based on a reference signal in a second range to generate a corresponding simulated analog signal; a third converting unit that converts the simulated analog signal based on a reference signal in a third range to generate a corresponding third digital signal. The feedback control unit continuously adjusts the second digital signal until the difference between the first and third digital signals is smaller than a prescribed value. The simulated analog signal obtained at that time becomes a stable simulated analog signal close to the original analog signal.

The first converting unit and the feedback control unit are arranged in the first zone. The second and third converting units are arranged in the second zone. This calibrating device also includes a communication device, which transfers the first, second, and third digital signals between the first and second zones. The communication device is an Internet network system.

The correcting value includes the ratio between the first, second, and third ranges or the difference between the first, second, and third reference signal ranges.

The feedback control unit is installed in a computer.

The third characteristic of the present invention is a method for establishing far-end calibration. This method uses a calibration signal to calibrate a far-end measurement instrument. This method includes the following steps: convert the calibration signal to generate a first digital signal; provide at least one correcting value to correct the first digital signal to generate the second digital signal; transfer the second digital signal to the far end; convert the second digital signal at the far end into a simulated calibration signal; convert the simulated calibration signal into a third digital signal; feed back the third digital signal to adjust the second digital signal until the difference between the third and first digital signals is smaller than a prescribed value so that /8
the simulated calibration approaches a stable simulated analog calibration signal, which is used to calibrate the measurement instrument; provide a signal detector to detect the calibration signal and the stable simulated calibration signal and adjust the correcting value based on the detection difference between the stable simulated calibration signal and the calibration signal; repeat the aforementioned steps until the detection difference is smaller than another prescribed value.

The fourth characteristic of the present invention is a method for establishing far-end calibration. This method uses a calibration signal to calibrate a far-end measurement instrument. This method includes the following steps: transfer the calibration signal to the far end via a digital conversion process and convert it back to a simulated calibration signal through an analog conversion; feed back the simulated calibration signal to adjust the digital conversion process until the simulated calibration signal becomes a stable simulated calibration signal close to the calibration signal; the stable simulated calibration signal is used to calibrate the measurement instrument.

The fifth characteristic of the present invention is a method for establishing far-end transfer. This method is used to transfer an analog signal to the far end. This method includes the following steps: convert the analog signal to generate a first digital signal; provide at least one correcting value to correct the first digital signal to generate a second digital signal; transfer the second digital signal to the far end; convert the second digital signal at the far end into a simulated analog signal; convert the simulated analog signal into a third digital signal; feed back the third digital signal to adjust the second digital signal until the difference between the third and first digital signals is smaller than a prescribed value so that the simulated analog signal approaches a stable simulated analog signal; provide a signal detector to detect the analog signal and the stable simulated analog signal and adjust the correcting value based on the detection /9
difference between the stable simulated analog signal and the analog signal; repeat the aforementioned steps until the detection difference is smaller than another prescribed value.

The sixth characteristic of the present invention is a method for establishing far-end transfer. This method is used to transfer an analog signal to the far end. This method includes the following steps: transfer the analog signal to the far end via a digital conversion process and convert it back to a simulated analog signal through an analog conversion; feed back the simulated analog signal to adjust the digital conversion process until the simulated analog signal becomes a stable simulated analog signal close to the original analog signal.

The seventh characteristic of the present invention is a method for calibrating the calibrating device described in Claim 1. This method has the following steps: use a signal detector to detect the calibration signal and the stable simulated calibration signal and adjust the correcting value based on the detection difference between the stable simulated calibration signal and the calibration signal; repeat the aforementioned steps until the detection difference is smaller than a prescribed value.

The eighth characteristic of the present invention is a method for calibrating the transfer device described in Claim 8. This method has the following steps: use a signal detector to detect the analog signal and the stable simulated analog signal and adjust the correcting value based on the detection difference between the stable simulated analog signal and the analog signal; repeat the aforementioned steps until the detection difference is smaller than a prescribed value.

<u>Brief description of the figures</u>

In order to make the aforementioned purposes, characteristics, and advantages of the present invention easier to understand, an application example will be explained in detail below, /10
based on the attached figures.

Figure 1 is a diagram illustrating the configuration of the transfer device disclosed in the application example of the present invention.

Figure 2 is a diagram illustrating the configuration of the calibrating device disclosed in the application example of the present invention.

Figure 3 shows the method for establishing far-end transfer disclosed in the present invention.

Figure 4 shows the details of the method for establishing far-end transfer disclosed in the present invention.

Figure 5 shows the calibrating method for the transfer device of the present invention.

Explanation of symbols

100	Transfer device
200	Calibrating device
10	First converting unit
20	Feedback control unit
30	Second converting unit
40	Third converting unit
50	Communication device
60	Calibrator
70	Measurement instrument
AS	Analog signal
CS	Calibration signal
DS1	First digital signal
DS2	Second Digital signal
DS3	Third digital signal
CE	Correcting value
SAS	Simulated analog signal
SCS	Simulated calibration signal
SSAS	Stable simulated analog signal
SSCS	Stable simulated calibration signal

<u>Detailed explanation of the invention</u>

Figure 1 shows the configuration of transfer device 100 of the present invention.

In the aforementioned calibrator, in order to maintain the accuracy of the provided calibrating voltage, the length of the connecting wire at the output terminal must be usually smaller than 1 m. The present invention provides a transfer device 100 used to transfer an analog signal AS over long distance with the distortion of the analog AS smaller than a prescribed /11

value. By using this transfer device 100, it is possible to accurately transfer the output calibrating voltage of the calibrator to the instrument to be calibrated to perform "far-end calibration." This transfer device 100 includes a first converting unit 10, a feedback control unit 20, a second converting unit 30, and a third converting unit 40.

The first converting unit 10 and feedback control unit 20 are located in the first zone that provides the calibrating voltage. When the electronic devices perform conversion between analog and digital signals (A/D, D/A conversion), the output is determined based on a reference signal provided from outside (usually a fixed reference voltage). The first converting unit 10 converts the analog signal AS based on a reference signal in a first range to generate a corresponding first digital signal DS1. Feedback control unit 20 corrects the first digital signal DS1 based on at least one correcting value CE to generate a second digital signal DS2 which is sent to the second zone. There may be a fairly long distance from the first zone to the second zone, for example, from USA to Japan. These zones, however, can also be different rooms in the same building.

The second, third converting units 30, 40 are located in the second zone. The second converting unit 30 converts the second digital signal DS2 based on a reference signal in a second range to generate a corresponding simulated analog signal SAS. The third converting unit 40 converts the simulated analog signal SAS based on a reference signal in a third range to generate a corresponding third digital signal DS3. The third digital signal DS3 is used as the feedback signal, which is sent back to feedback control unit 20.

In the following, the correcting value CE used by feedback control unit 20 will be explained. The correcting value CE is set appropriately to offset the errors between the reference signals (voltages) of the first, second, and third ranges. Ideally, the same reference signal /12
(voltage) is used to perform conversion between analog and digital signals so that there is no need to worry about the aforementioned error problem. In fact, however, the voltage source of the second zone is different from the reference voltage of the first zone. For example, when comparing two groups of voltages of 5 V measured in the two zones, the 5 V in the second zone may be just the 5.001 V in the first zone. Consequently, when the analog signal AS is output from the first zone after the digital conversion (that is, the first digital signal DS1), it is necessary to make an adjustment using the aforementioned correcting value in order to offset the difference caused by the different conditions at the two ends. It is preferable for the correcting value to include the range ratio between the first, second, and third ranges to offset the signal increase or decrease occurring during the conversion process and to include the actual differences between the zero potentials of the first, second, and third ranges to correct the signal deviation occurring during the conversion process.

In addition, in order to overcome the errors caused by other factors (such as temperature, humidity, vibration, etc.), said feedback control unit 20 continuously feeds back the third digital signal DS3 and adjusts the second digital signal DS2 until the difference between the first and third digital signals DS1, DS3 is smaller than a prescribed value, so that the simulated analog signal SAS becomes a stable simulated analog signal SSAS close to the original analog signal.

There is also a communication device 50 used to transfer the first, second, third digital signals between the first and second zones. It is preferable that said communication device 50 be the current Internet network system or local network. In addition, the feedback control unit is preferably installed in a computer, that is, installed in the form of software.

Since accurate far-end transfer can only be achieved using digital signals, but digital signals can only reflect the subjective voltage value at one end and are unable to truly reflect the relative voltage value with respect to the other end, it is not possible to obtain the values of the aforementioned first, second, and third ranges with respect to the first zone via remote communication (including telephone consultation). Therefore, the present invention can only /13
obtain the aforementioned correcting value CE manually. The same signal detector is used to conduct plural detection groups with respect to the input and output signals (that is, the analog signal AS and the simulated analog signal SAS) at the two ends to estimate the aforementioned required correcting value CE. The adjusted correcting value CE can be specially used to transfer the analog signal AS in the second zone (as long as the unit devices in the first and second zones are not changed).

As shown in Figure 2, when providing the calibration service, a calibration signal CS (usually, a calibrating voltage) provided by a signal-generating unit, that is, calibrator 60 is sent as said analog signal AS to the second zone. At that time, the calibrating device 200 disclosed in the present invention can be used. The generated stable simulated analog signal SSAS is called stable simulated calibration signal SSCS in calibrating device 200. This signal is used to calibrate a measurement instrument 70. The other units are not changed and will not be explained again.

If there are many customers who need the calibration service, it is necessary to send somebody to each customer to detect a specific group of correcting values for that customer that will be used for the calibration service later. Of course, in order to maintain the accuracy, it is necessary to conduct detection periodically to correct each correcting value.

The aforementioned device of the present invention is based on the method disclosed in the present invention. In the following, the method for establishing far-end transfer disclosed in the present invention will be explained based on the block diagram shown in Figure 3. As described above, the far-end transfer is used to transfer an analog signal AS to a far end. This method includes the following steps: (S1) transfer this analog signal AS to the far end via a

digital conversion process and convert it back into a simulated analog signal SAS via an analog conversion; and (S2) feed back the simulated analog signal SAS to adjust the digital conversion process until the simulated analog signal SAS becomes a stable simulated analog signal SSAS /14
close to the original analog signal.

Figure 4 shows the method for establishing far-end transfer of the present invention in greater detail. It includes the following steps: (S1) convert the analog signal to generate a first digital signal DS1; (S2) provide at least one correcting value CE to correct the first digital signal DS1 to generate a second digital signal DS2; (S3) transfer the second digital signal DS2 to the far end; (S4) convert the second digital signal DS2 at the far end into a simulated analog signal SAS; (S5) convert the simulated analog signal SAS into a third digital signal DS3; (S6) feed back the third digital signal DS3 to adjust the second digital signal DS2 until the difference between the third and first digital signals DS3, DS1 is smaller than a prescribed value so that the simulated analog signal SAS approaches a stable simulated analog signal SSAS; (S7) provide a signal detector to detect the analog signal AS and the stable simulated analog signal SSAS and adjust the correcting value based on the detection difference between the stable simulated analog signal SSAS and the analog signal AS; (S8) repeat the aforementioned steps until the detection difference is smaller than another prescribed value.

The present invention also discloses a far-end calibrating method based on the aforementioned far-end transfer method. In this case, the aforementioned calibration signal CS is used as the aforementioned analog signal AS, and the aforementioned stable simulated analog signal SSAS is used to provide the calibrating voltage for a measurement instrument to be calibrated at the far end. The rest of this far-end calibrating method is the same as the far-end transfer method and will not be explained again.

Also, as described above, the correcting value for transfer device 100 is adjusted based on the calibrating method disclosed in the present invention and is used to calibrate transfer device 100. It includes the steps shown in Figure 5: (S1) provide a signal detector to detect the analog signal AS and the stable simulated analog signal SSAS and adjust the correcting value based on /15
the detection difference between the stable simulated analog signal SSAS and the analog signal AS; and (S2) repeat the aforementioned step until the detection difference is smaller than a prescribed value.

The calibrating device 200 using said transfer device 100 can also be calibrated using the aforementioned method. In this case, the calibration signal CS is used as the analog signal AS, and the stable simulated calibration signal SSCS is used as the stable simulated analog signal SSAS. The rest part is the same and will not be explained again.

When using the device and method of the present invention to conduct far-end measurement, it is possible to conduct calibration via a communication system, such as an

Internet network, by only establishing the data of the correcting values at the far end in advance. There is no need to transport the measurement instrument every time that a calibration is required. In this way, it is possible to effectively save manpower, material sources, and time, etc. The present invention is particularly important to the organizations that need to frequently calibrate their measurement instruments.

Although the present invention has been explained in detail based on the aforementioned application example, it is not limited to this application example. Anybody who is familiar with this technology can make changes or modifications without deviating from the main point of the present invention. Consequently, the protection range of the present invention should be determined based on the attached claims.

Claims /16

1. A type of calibrating device characterized by the following facts: the calibrating device uses a calibration signal in a first zone to calibrate a measurement instrument in a second zone; this calibrating device includes:

a signal-generating unit that can generate the aforementioned calibration signal;

a first converting unit that can convert the calibration signal based on a reference signal in a first range to generate a corresponding first digital signal;

a feedback control unit that corrects the first digital signal based on at least one correcting value to generate a second digital signal;

a second converting unit that converts the second digital signal based on a reference signal in a second range to generate a corresponding simulated calibration signal;

a third converting unit that converts the simulated calibration signal based on a reference signal in a third range to generate a corresponding third digital signal;

the feedback control unit continuously adjusts the second digital signal until the difference between the first and third digital signals is smaller than a prescribed value; the simulated calibration signal obtained at that time is a stable simulated calibration signal close to the calibration signal; the stable simulated calibration signal is used to calibrate the measurement instrument.

2. The calibrating device described in Claim 1 characterized by the fact that the signal-generating unit, the first converting unit, and the feedback control unit are arranged in the first zone, while the second and third converting units are arranged in the second zone.

3. The calibrating device described in Claim 2 characterized by also including a communication device, which transfers the first, second, and third digital signals between the first and second zones.

4. The calibrating device described in Claim 3 characterized by the fact that the communication device is an Internet network system.

5. The calibrating device described in Claim 1 characterized by the fact that the correcting value includes the ratio between the first, second, and third ranges. /17

6. The calibrating device described in Claim 1 characterized by the fact that the correcting value includes the difference between the first, second, and third reference signal ranges.

7. The calibrating device described in Claim 1 characterized by the fact that the feedback control unit is installed in a computer.

8. A type of transfer device characterized by the following facts: the transfer device is used to transfer an analog signal from a first zone to a second zone; this transfer device includes:

a first converting unit that converts the analog signal based on a reference signal in a first range to generate a corresponding first digital signal;

a feedback control unit that corrects the first digital signal based on at least one correcting value to generate a second digital signal sent to the second zone;

a second converting unit that converts the second digital signal based on a reference signal in a second range to generate a corresponding simulated analog signal;

a third converting unit that converts the simulated analog signal based on a reference signal in a third range to generate a corresponding third digital signal;

the feedback control unit continuously adjusts the second digital signal until the difference between the first and third digital signals is smaller than a prescribed value; the simulated analog signal obtained at that time becomes a stable simulated analog signal close to the original analog signal.

9. The transfer device described in Claim 8 characterized by the fact that the first converting unit and the feedback control unit are arranged in the first zone, while the second and third converting units are arranged in the second zone.

10. The transfer device described in Claim 9 characterized by also including a
communication device, which transfers the first, second, and third digital signals between the /18
first and second zones.

11. The transfer device described in Claim 8 characterized by the fact that the communication device is an Internet network system.

12. The transfer device described in Claim 8 characterized by the fact that the correcting value includes the ratio between the first, second, and third ranges.

13. The transfer device described in Claim 8 characterized by the fact that the correcting value includes the difference between the first, second, and third reference signal ranges.

14. The transfer device described in Claim 8 characterized by the fact that the feedback control unit is installed on a computer.

15. A method for establishing far-end calibration characterized by the following facts: this method uses a calibration signal to calibrate a far-end measurement instrument; this method includes the following steps:

convert the calibration signal to generate a first digital signal;

provide at least one correcting value to correct the first digital signal to generate the second digital signal; transfer the second digital signal to the far end;

convert the second digital signal at the far end into a simulated calibration signal; convert the simulated calibration signal into a third digital signal;

feed back the third digital signal to adjust the second digital signal until the difference between the third and first digital signals is smaller than a prescribed value, so that the simulated calibration approaches a stable simulated analog calibration signal, which is used to calibrate the measurement instrument;

provide a signal detector to detect the calibration signal and the stable simulated calibration signal and adjust the correcting value based on the detection difference between the stable simulated calibration signal and the calibration signal; and

repeat the aforementioned steps until the detection difference is smaller than another prescribed value.

16. A method for establishing far-end calibration characterized by the following facts: the far-end calibration uses a calibration signal to calibrate a far-end measurement instrument; this method includes the following steps:

transfer the calibration signal to the far end via a digital conversion process and convert it back into a simulated calibration signal via an analog conversion; and

feed back the simulated calibration signal to adjust the digital conversion process until the simulated calibration signal becomes a stable simulated calibration signal close to the calibration signal; the stable simulated calibration signal is used to calibrate the measurement instrument.

17. A method for establishing far-end transfer characterized by the following facts: this method is used to transfer an analog signal to the far end; this method includes the following steps:

convert the analog signal to generate a first digital signal; provide at least one correcting value to correct the first digital signal to generate a second digital signal; transfer the second digital signal to the far end;

convert the second digital signal at the far end into a simulated analog signal; convert the simulated analog signal into a third digital signal;

feed back the third digital signal to adjust the second digital signal until the difference between the third and first digital signals is smaller than a prescribed value so that the simulated analog signal approaches a stable simulated analog signal;

provide a signal detector to detect the analog signal and the stable simulated analog signal and adjust the correcting value based on the detection difference between the stable simulated analog signal and the analog signal; and

repeat the aforementioned steps until the detection difference is smaller than another prescribed value.

18. A method for establishing far-end transfer characterized by the following facts: this method is used to transfer an analog signal to a far end; this method includes the following steps:

transfer the analog signal to the far end via a digital conversion process and convert it back to a simulated analog signal through an analog conversion; and

feed back the simulated analog signal to adjust the digital conversion process until the simulated analog signal becomes a stable simulated analog signal close to the original analog signal.

19. A method for calibrating the calibrating device described in Claim 1 having the following steps: use a signal detector to detect the calibration signal and the stable simulated calibration signal and adjust the correcting value based on the detection difference between the stable simulated calibration signal and the calibration signal; and

repeat the aforementioned steps until the detection difference is smaller than a prescribed value.

20. A method for calibrating the transfer device described in Claim 8 having the following steps: use a signal detector to detect the analog signal and the stable simulated analog signal and adjust the correcting value based on the detection difference between the stable simulated analog signal and the analog signal; and

repeat the aforementioned steps until the detection difference is smaller than a prescribed value.

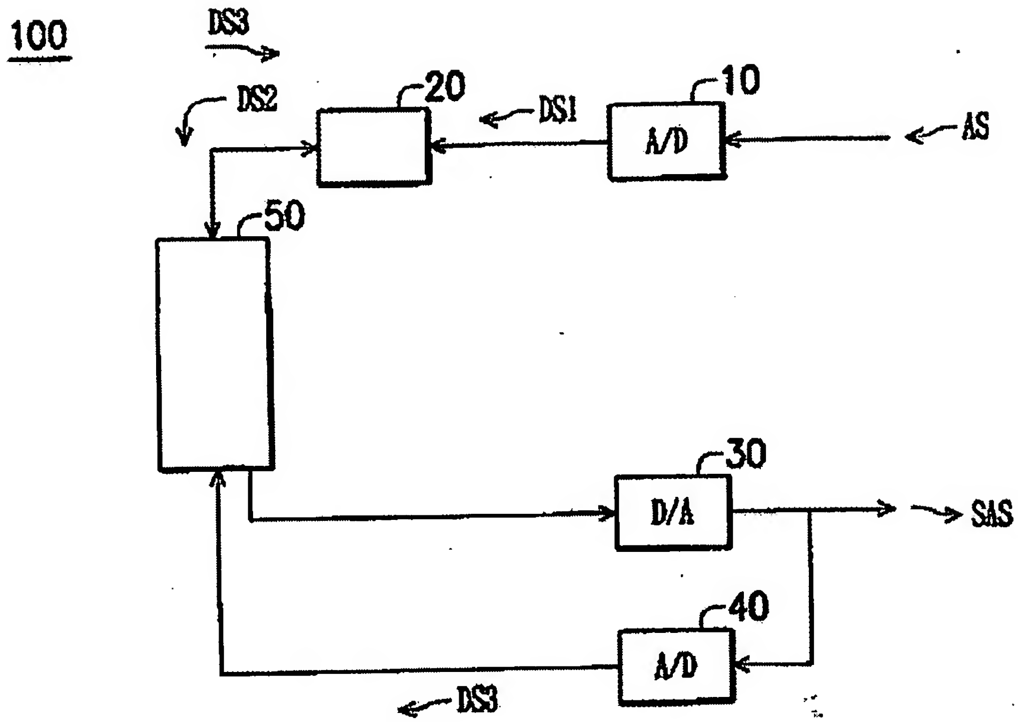

Figure 1

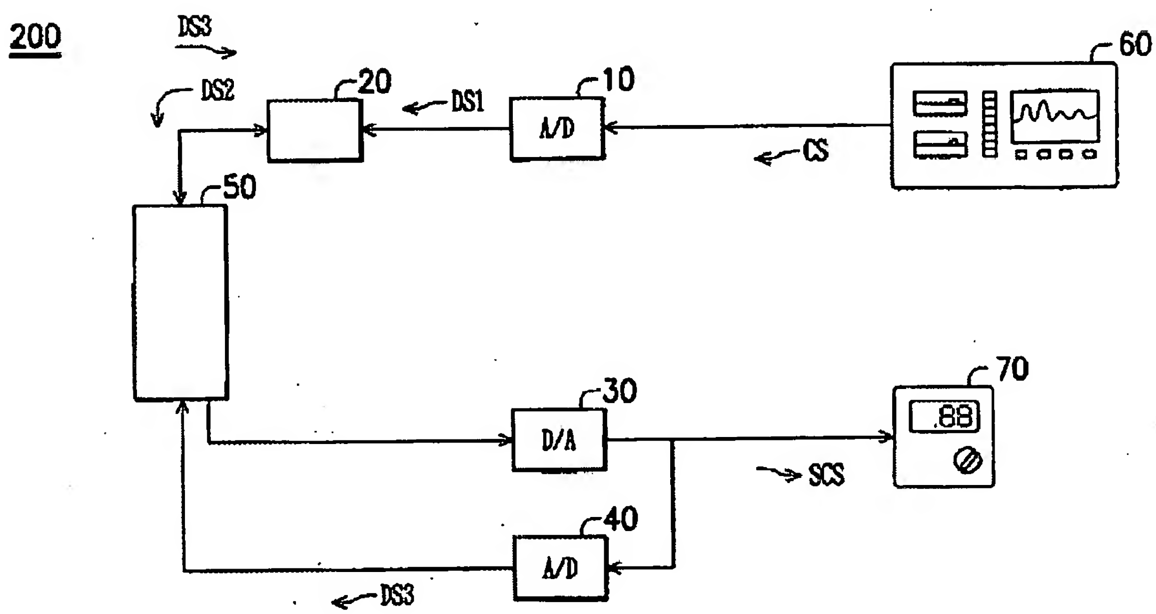

Figure 2

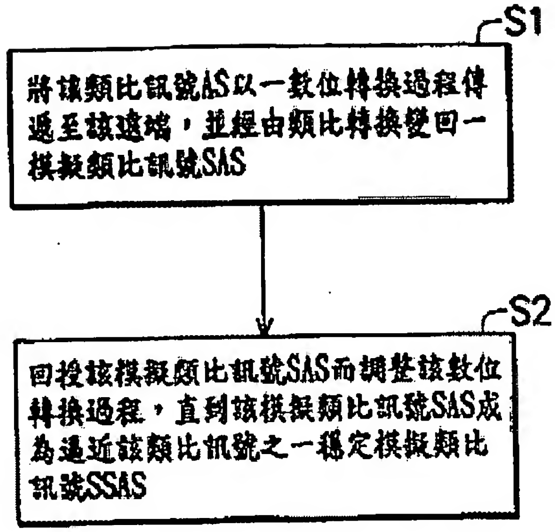

Figure 3

Key: S1 Transfer analog signal AS to a far end via a digital conversion process and convert it back into a simulated analog signal SAS via an analog conversion

S2 Feed back the simulated analog signal SAS to adjust the digital conversion process until the simulated analog signal SAS becomes a stable simulated analog signal SSAS close to the analog signal

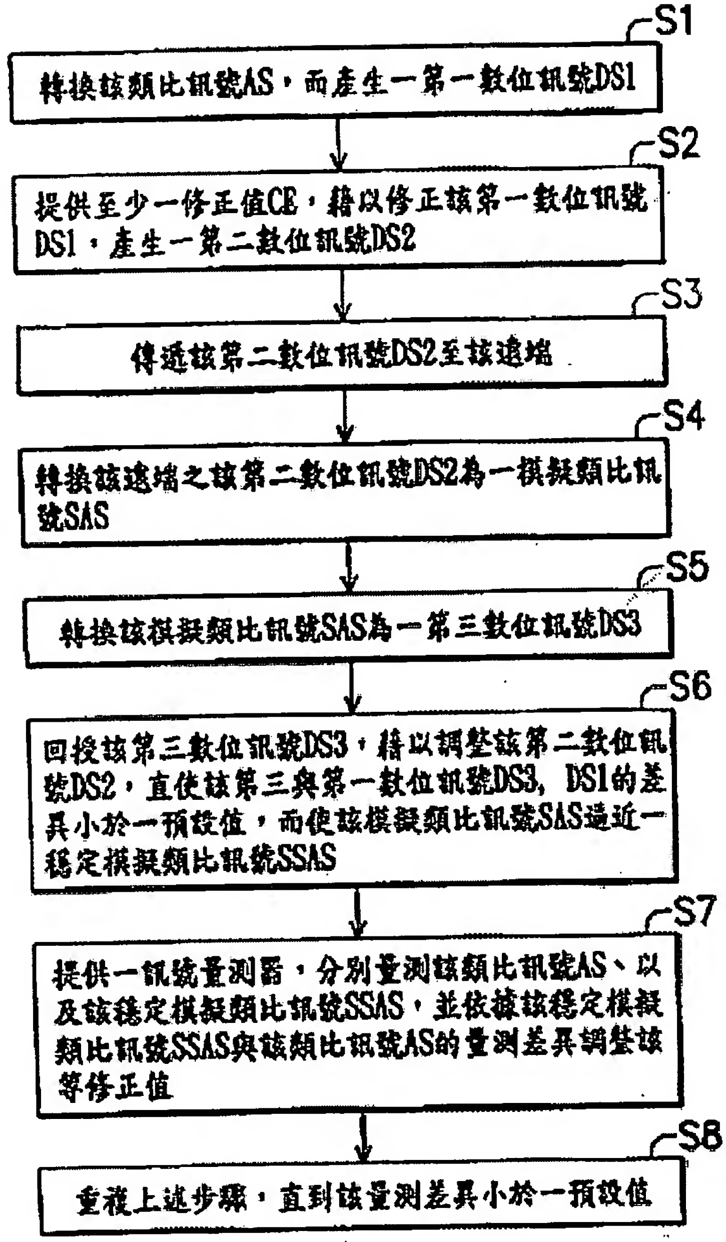

Figure 4

Key:
- S1 Convert analog signal AS to generate the first digital signal DS1
- S2 Provide at least one correcting value CE to correct the first digital signal DS1 to generate a second digital signal DS2
- S3 Transfer the second digital signal DS2 to the far end
- S4 Convert the second digital signal DS2 at the far end into a simulated analog signal SAS
- S5 Convert the simulated analog signal SAS into a third digital signal DS3

S6 Feed back the third digital signal DS3 to adjust the second digital signal DS2 until the difference between the third and first digital signals DS3, DS1 is smaller than a prescribed value so that the simulated analog signal SAS approaches a stable simulated analog signal SSAS

S7 Provide a signal detector to detect the analog signal AS and the stable simulated analog signal SSAS and adjust the correcting value based on the detection difference between the stable simulated analog signal SSAS and the analog signal AS

S8 Repeat the aforementioned steps until the detection difference is smaller than another prescribed value

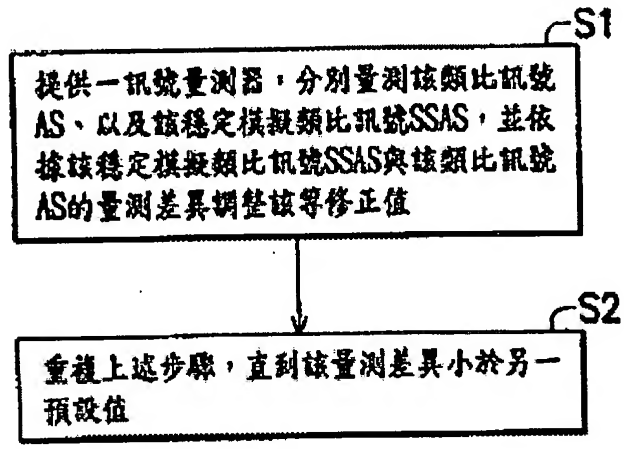

Figure 5

Key: S1 Provide a signal detector to detect the analog signal AS and stable simulated analog signal SSAS and adjust the correcting value based on the detection difference between the stable simulated analog signal SSAS and the analog signal AS

S2 Repeat the aforementioned step until the detection difference is smaller than another prescribed value